

American

POTATO JOURNAL

Volume 34

May 1957

Number 5

CONTENTS

- Interrelation among measurements of browning of processed potatoes and sugar components
SIGMUND SCHWIMMER, C. E. HENDEL, W. O. HARRINGTON
AND R. L. OLSON 119
- Survival of the ring rot bacteria in wet potato pulp from the starch factories
REINER BONDE AND J. S. GETCHELL 133

NEWS AND REVIEWS

- Red Dot Foods, Inc. and its potato research program
F. J. STEVENSON 136
- How we can interpret the zero tolerance for bacterial ring rot in certified seed potatoes
COMMITTEE REPORT 142
- New type potato planter invented
JOHN S. GARDNER 149
- Book Review — Farm Trouble
FIRMAN BEAR 150
- Chip sales soar to new high 150
- Processed potato products provide important outlet for U. S. crop 151

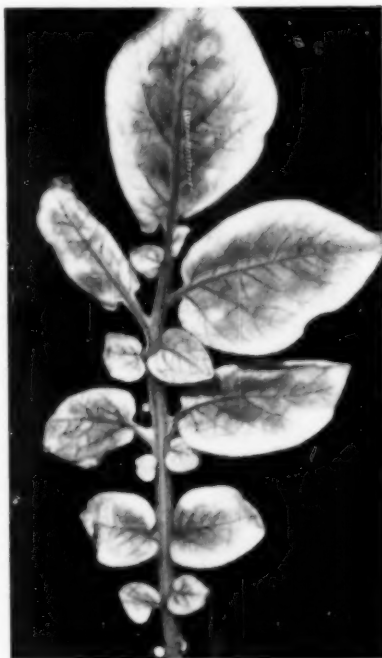
Official Publication of
THE POTATO ASSOCIATION OF AMERICA
NEW BRUNSWICK, NEW JERSEY, U. S. A

when your potato leaves tell you...

it's **TOO LATE FOR TOP-PROFITS**

When potato plants show a yellowing between the veins of the lower leaves, like this, they lack available magnesium and can't produce maximum yields and solid, high-starch content.

Sul-Po-Mag® in premium-type complete potato fertilizers supplies the fast-acting, water-soluble magnesium needed in many potato growing soils to increase yields of U.S. No. 1 potatoes 50, 80, and 100 bushels an acre. Premium-type fertilizers containing SPM also provide low chloride sulphate of potash. SPM does not increase the danger of potato scab. It is neutral and does not raise the pH of soils. Sul-Po-Mag in complete potato fertilizers is your assurance of a balanced combination of water-soluble double sulphate of potash and magnesium.



Look for this identifying Seal of Approval when you buy. It's your assurance of extra-value fertilizer.

**SPM Premium-type
fertilizers guarantee**

Sul-Po-Mag®



Water-Soluble Double Sulphate of Potash-Magnesia
($K_2SO_4 \cdot 2MgSO_4$) 22% K_2O - 18% MgO

**S·P·M
PREMIUM**

Premium quality fertilizer certified through use of a balanced combination of the water-soluble magnesium and potash obtained from Sul-Po-Mag®.

potash division

INTERNATIONAL MINERALS & CHEMICAL CORPORATION
20 NORTH WACKER DRIVE • CHICAGO, ILLINOIS



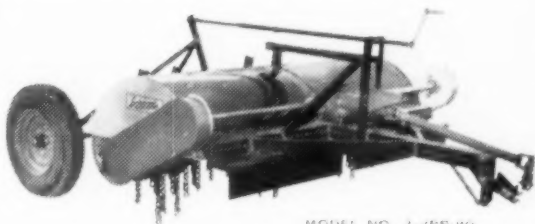
"LOCKWOOD"

- A Symbol of Service!!
- A Sign of Quality!!

PREPARE YOUR POTATO CROP FOR
PROPER DIGGING WITH A

LOCKWOOD VINE BEATER

- Extra Light Running.
- Flails Contoured to Fit Rows.
- Will Fit All Rows From 32" to 40".



MODEL NO. 2-48P-40

— Manufacturers of a Complete Line of Potato and Onion Machinery —

LOCKWOOD GRADERS

GERING, NEBR.

— 10 BRANCHES THROUGHOUT AMERICA —

Potash and Potatoes

Potatoes are a major item in the American diet. Potash is a major item in the potato diet. Potatoes are greedy feeders on potash. They use more of this plant food than nitrogen and phosphoric acid combined. To grow a good crop of No. 1's, soil and fertilizer must supply at least 200 lbs. of available potash (actual K_2O) per acre. Consult your official agricultural adviser or experiment station about the fertility of your soil. Write us for information and literature on how to fertilize your crops.

AMERICAN POTASH INSTITUTE, INC.

1102 Sixteenth St., N.W.

Washington 6, D. C.

Member Companies: American Potash & Chemical Corporation • Duval Sulphur & Potash Company • Potash Company of America • Southwest Potash Corporation • United States Potash Company
Division of United States Borax & Chemical Corporation

American Potato Journal

PUBLISHED BY
THE POTATO ASSOCIATION OF AMERICA
NEW BRUNSWICK, N. J.

EXECUTIVE COMMITTEE

J. C. CAMPBELL, *Editor-in-Chief*
WM. H. MARTIN, *Honorary Editor*
E. S. CLARK, *Associate Editor*

Rutgers University, New Brunswick, New Jersey

R. W. HOUHAS, *President* University of Wisconsin, Madison, Wis.
N. M. PARKS, *Vice President* Department of Agriculture, Ottawa, Canada
W. J. HOOKER, *Secretary* Michigan State University, East Lansing, Mich.
JOHN C. CAMPBELL, *Treasurer* Rutgers University, New Brunswick, N. J.
CECIL FRUTCHIEY, *Past President* Colorado A & M College, Ft. Collins, Colo.
ORRIN C. TURNQUIST, *Director* University of Minnesota, St. Paul 1, Minn.
WM. G. HOYMAN, *Director* North Dakota Agricultural College, Fargo, N. D.
E. J. WHEELER, *Director* Michigan State University, East Lansing, Mich.

Price \$4.00 per year in North America; \$5.00 in other countries.

Entered as second class matter at New Brunswick, N. J., March 14, 1942 under Act of March 3, 1879. Accepted for mailing at special rate of postage provided for in section 412, Act of February 28, 1925, authorized on March 14, 1928.

SUSTAINING MEMBERS

STARKS FARMS INC. Route 3, Rhinelander, Wisconsin
BACON BROTHERS 1425 So. Racine Ave., Chicago 8, Illinois
L. L. OLDS SEED CO. Madison, Wisconsin
FRANK L. CLARK, *Founder* — Clark Seed Farms Richford, New York
RED DOT FOODS, INC. Madison, Wisconsin
ROHM & HAAS COMPANY Washington Square, Philadelphia 5, Pennsylvania
WISE POTATO CHIP CO. Berwick, Pennsylvania
JOHN BEAN DIVISION, FOOD MACHINERY CORP. Lansing 4, Michigan
S. KENNEDY & SONS, Growers and Shippers of Potatoes and Onions Clear Lake, Iowa
OLIN MATHIESON CHEMICAL CORP. Mathieson Bldg., Baltimore 3, Maryland
AMERICAN AGRICULTURAL CHEMICAL CO. Carteret, New Jersey
LOCKWOOD GRADER CORP. Gering, Nebraska
EDWARD H. ANDERSON & CO. 1425 So. Racine Ave., Chicago 8, Illinois
E. I. DU DONT DE NEMOURS & CO. (INC.),
Grasselli Chemicals Dept. Wilmington 98, Delaware

INTERRELATION AMONG MEASUREMENTS OF BROWNING OF PROCESSED POTATOES AND SUGAR COMPONENTS¹

SIGMUND SCHWIMMER, C. E. HENDEL, W. O. HARRINGTON,
AND R. L. OLSON²

The fact that a highly significant relationship exists between the apparent "reducing sugar" content of potatoes and the extent of non-enzymatic browning of processed potato products such as chips, French fries, and dehydrated dice, has been amply documented in several recent reviews (1, 5, 11). Furthermore, substantial evidence shows that this relation is casual and direct, owing, at least in part, to a typical Maillard reaction between the sugar components and alpha amino groups present in the nitrogenous constituents of the tuber (11). However, a survey of the quantitative data in the literature reveals that there is considerable scatter in the plots of browning vs. reducing sugar. Since it is reasonable to assume a degree of precision well within the limits of this scatter in the measurements of so-called "reducing sugars", the possible sources of this scatter can be sought in the following factors: (a) extraction and clarification procedures for the determination of the sugars; (b) estimates of browning susceptibility; (c) the inclusion (or non-inclusion) of sugars and reducing substances other than the individual reducing sugars; (d) influence of variations in the relative amounts of the components comprising the reducing sugars; (e) alteration of sugar content caused by processing treatment; (f) influence of level and composition of the amino constituents which enter into the browning reactions; (g) variations in levels and relative importance of other direct or possibly auxiliary factors, the latter of which may profoundly influence but may not directly enter into the browning process.

As part of a comprehensive study of compositional factors influencing browning of processed potato products, several varieties of potatoes, each of which was subjected to a controlled but varied post-harvest history, were analyzed chromatographically for individual sugar components and derivatives by improved methods of extraction, clarification, and separation (13, 14, 19). Since the major sugars found were only sucrose, glucose, and fructose, an effort was made to find statistical interrelationships (including parameter, the "discriminatory index") among levels of these sugars and degrees of soluble colors measured in potato chips and dehydrated potato dice by improved procedures (3, 4). Data are also presented on the course of the accelerated browning of dehydrated dice as affected by potato variety.

MATERIALS AND METHODS

Preparation and Processing of Potatoes. Raw materials included one lot each of the White Rose and Russet Burbank varieties ("western potatoes"). Details of history, storage conditions, etc. are given in a previous paper (14). Also used were one lot each of Katahdin and Green Mountain grown in Maine. At specified storage intervals 15- to 20-pound lots of tubers were hand-peeled and a sample of several half tubers was

¹Accepted for publication January 14, 1957.

²Western Utilization Research Branch, Agricultural Research Service, United States Department of Agriculture, Albany 10, Cal.

prepared. The ends of each tuber were removed and the remainder was sliced transversely. The slices were washed in cold water, blotted with towels, and fried in deep fat.

The remainder of the half tubers were diced mechanically ($\frac{3}{8} \times \frac{3}{8} \times \frac{3}{16}$ -inch), intimately mixed, and 400 grams placed in boiling ethanol for subsequent sugar analyses (14).

The remainder of the dice were blanched in steam at 212°F. for 3 minutes on wire-mesh trays at a loading of 1.5 pounds per square foot. The dice were then dried in a cross-flow cabinet drier at an air temperature of 140°F. for 5 hours. The dehydrated dice were stored at 32°F. in nitrogen for subsequent study.

For the preparation of chips, sliced lots (1/16-inch in thickness) containing 75 to 85 grams per batch were fried in hot oil initially at 190°C. until cessation of bubbling was observed (80 to 100 seconds). After draining and cooling, samples of the chips were placed in tightly closed jars and stored at -10°F. for subsequent evaluation. Such a frying technique results in chips with moisture content at about 2.5 per cent, as you will note in tables 3 and 4.

Analyses and Tests. For the measurement of rate of browning, the dehydrated dice were adjusted to 8 per cent moisture content (4, 8) either by addition of the necessary amount of water (dropwise) followed by holding with periodic mixing on each of several successive days, or by removal of water from the dice by placing them in an evacuated desiccator over the appropriate amount of calcium oxide. The moisture-adjusted dice were then canned in 211 x 300 cans (60 grams per can) and placed in a water bath at 50°C. Dice from the Maine tubers were in evacuated cans, which were tested for loss of vacuum at the end of the browning test. Moisture content of the browned dice was also measured.

The samples, after removal from the water bath at daily intervals, were ground (<2 mm.), extracted with 2 per cent acetic acid, and the filtered extract was mixed with an equal volume of acetone. After filtration, the optical density of this second filtrate was measured in a 5-cm. optical cell at 420 m μ in a Beckman DU spectrophotometer. Results are expressed as increase in optical density ($\times 1000$) per day under the specified conditions of wave length, length of cell, and concentration referred to the original weight of dice (5 per cent). This measurement is designated as:

$$\Delta E_{5 \text{ cm. } 420 \text{ m}\mu/\text{day} \times 10^3}^{5\%}$$

The foregoing procedures for heat damage and for measuring degree of browning are similar to those used in other studies at this laboratory (4, 6, 7).

Chip Color and Analytical. The oil content of the chips was determined by the CCl_4 extraction procedure (20). The defatted chips were then extracted for 2 hours with 40 times by volume of their weight of 55 per cent (v/v) ethyl alcohol. After filtering (Whatman No. 3 paper) and diluting with an equal volume of water the color was read in a Klett colorimeter with a No. 420 filter. The color values are expressed as Klett

readings. The moisture content of the chips was determined by drying at 70°C. (vacuum) for 40 hours.

Analytical procedures for the determination of the individual sugars of the potatoes are given in a previous publication (14). Total nitrogen of the dice was determined by the Kjeldahl procedure and the amino nitrogen by the Van Slyke procedure.

RESULTS

Browning vs. Composition. Pertinent data on browning rate and analytical values for the Maine potato varieties are shown in table 1. These data show an interrelationship between specific gravity, reducing sugars, and browning. The browning rates of dehydrated dice from the western potatoes stored at 3 temperatures for varying times are shown in table 2. Sugar data have been published previously (14).

TABLE 1.—*Browning rates and other data for Maine potatoes.*

Variety	Sp. Gr.	Sugar, Per cent ¹		Nitrogen, Per cent ¹		Browning ² Rate
		Reducing	Total	Amino	Total	
Katahdin	1.065-1.069	0.62	—	0.66	1.97	18.5
	1.075-1.079	0.53	—	0.61	1.80	11.5
	1.090-1.094	0.46	—	0.53	1.55	8.6
	1.100-1.104	0.46	—	0.48	1.44	8.7
Green Mountain	1.075-1.079	1.57	2.54	0.63	1.96	21.4
	1.085-1.089	1.28	2.37	0.72	1.54	19.0
	1.095-1.099	1.01	1.93	0.50	1.34	14.7
	1.105-1.109	1.31	2.36	0.48	1.22	14.0

¹MFB, determination on the unblanched dice.

² $\Delta E \frac{5\%}{5 \text{ cm.}}$ 420 m μ /day $\times 10^3$, as defined in text.

TABLE 2.—*Browning rates of dehydrated dice from western potatoes.*¹

Storage Temperature		Raw Storage Time, Weeks				
°F.	0	1	2	4	10	18
Browning Rate, White Rose Variety						
40	6.0	18.3	32.2	101.0	53.7	34.2
50	6.0	13.1	16.7	21.5	—	—
70	6.0	6.9	9.6	8.1	5.9	8.6
Browning Rate, Russet Burbank Variety						
40	14.0	23.0	24.0	28.0	25.0	26.0
50	14.0	16.0	13.0	13.0	—	9.2
70	14.0	15.0	13.0	9.6	5.8	4.0

¹ $\Delta E \frac{5\%}{5 \text{ cm.}}$ 420 m μ /day $\times 10^3$ as defined in text (average values).

TABLE 3.—*Color, moisture, and oil content of potato chips, White Rose variety.*

Storage temp. °F.	Raw Storage Time, Weeks						Average ²
	0	1	2	4	10	18	
Moisture (Per cent)							
40	2.22	2.38	2.43	2.42	2.32	2.37	2.38 ± 0.05
50	2.22	2.35	2.22	2.36	3.20	2.51	2.53 ± 0.27
70	2.22	2.69	3.03	2.19	2.61	1.58	2.42 ± 0.39 2.43 ± 0.24 ³
Oil (Per cent)							
40	41.2	36.4	39.1	37.7	37.0	37.6	37.4 ± 1.0
50	41.2	38.8	37.6	38.0	34.8	36.0	37.0 ± 1.2
70	41.2	39.2	37.4	37.5	36.4	35.5	37.2 ± 0.2 37.5 ± 1.2 ³
Soluble Color							
40	34	94	320	630	535	396	395 ± 150
50	34	65	129	145	49	103	107 ± 24
70	34	47	38	44	35	65	46 ± 8
Subjective Appraisal ¹							
40	1	3	5	5	5	5	4.6 ± 0.6
50	1	2	4	4	3	4	3.4 ± 0.6
70	1	2	1	3	1	3	2.0 ± 0.8

¹1 = Very Good; 2 = Good; 3 = Passable; 4 = Dark; 5 = Very Dark.²Average of stored samples ± average deviation of a single measurement; initial values not included.³Overall average including initial sample.

The total and amino nitrogen contents of the dice were relatively constant and thus independent of the temperature or time of storage of the tuber. The total nitrogen for the dice from White Rose and Russet Burbank averaged 1.35 ± 0.03 and 1.53 ± 0.03 per cent on a moisture-free basis (average deviation of a single measurement), respectively. The respective amino nitrogen values were 0.48 ± 0.05 and 0.64 ± 0.03 .

Tables 3 and 4 present data on color, moisture, oil content, and subjective appraisal of the chips prepared from the same lots of western potatoes used for dice dehydration as outlined under "Methods". It will be noted that for both western varieties the color, as expected, was greater at the lower than at the higher raw storage temperatures. Furthermore, the average color developed in both processed products was greater in the White Rose than in the Russet Burbank. The average oil content of the chip was slightly, but also significantly, greater for White Rose (in

TABLE 4.—*Color, moisture, and oil content of potato chips, Russet Burbank variety.*

Storage temp. °F.	Raw Storage Time, Weeks						Average ²
	0	1	2	4	10	18	
Moisture (Per cent)							
40	2.66	2.44	2.92	2.29	1.65	2.46	2.35 ± 0.50
50	2.66	2.60	2.45	2.61	2.13	2.13	2.38 ± 0.20
70	2.66	2.41	2.71	2.66	1.90	2.25	2.39 ± 0.25
							2.39 ± 0.25 ³
Oil (Per cent)							
40	35.4	35.4	33.5	37.5	37.9	35.4	35.4 ± 1.0
50	35.4	37.4	36.3	35.5	37.0	36.4	36.2 ± 0.4
70	35.4	37.3	35.4	34.0	36.8	33.3	35.6 ± 0.7
							35.7 ± 1.2 ³
Soluble Color							
40	54	109	89	214	175	171	151 ± 42
50	54	51	49	73	47	61	58 ± 7
70	54	59	46	58	33	30	45 ± 11
Subjective Appraisal ¹							
40	3	3	4	4	4	4	3.8 ± 0.4
50	3	2	3	3	3	3	2.8 ± 0.4
70	3	1	2	2	1	1	1.4 ± 0.5

^{1,2,3}See table 3.

agreement with recent findings of Wright (21), but there were no significant differences with respect to raw storage temperatures. The moisture values of the chips exhibited no significant trend and were reasonably uniform over the entire experiment, indicating uniformity of the cooking technique used.

Browning vs. Composition—Conventional Statistical Treatment. A typical plot of the individual sugar content of raw western tubers (Without regard to variety) against the color values of the chip is shown in figure 1. The straight lines drawn through these points are the statistical lines of regression (assuming linear relations between sugar and color) obtained from the statistical constants tabulated in table 5. It will be noted that fair correlation (r greater than 0.90) was obtained in all cases except for sucrose. Good correlation with chip color was obtained for both reducing sugar and glucose. These conclusions are brought out more strikingly by comparison of values of the standard error of estimate ($\sigma_{y.x}$). Thus the $\sigma_{y.x}$ for glucose or reducing sugar as a measure of chip color was one-half that of the total sugar or dice color as such a measure. On the other hand,

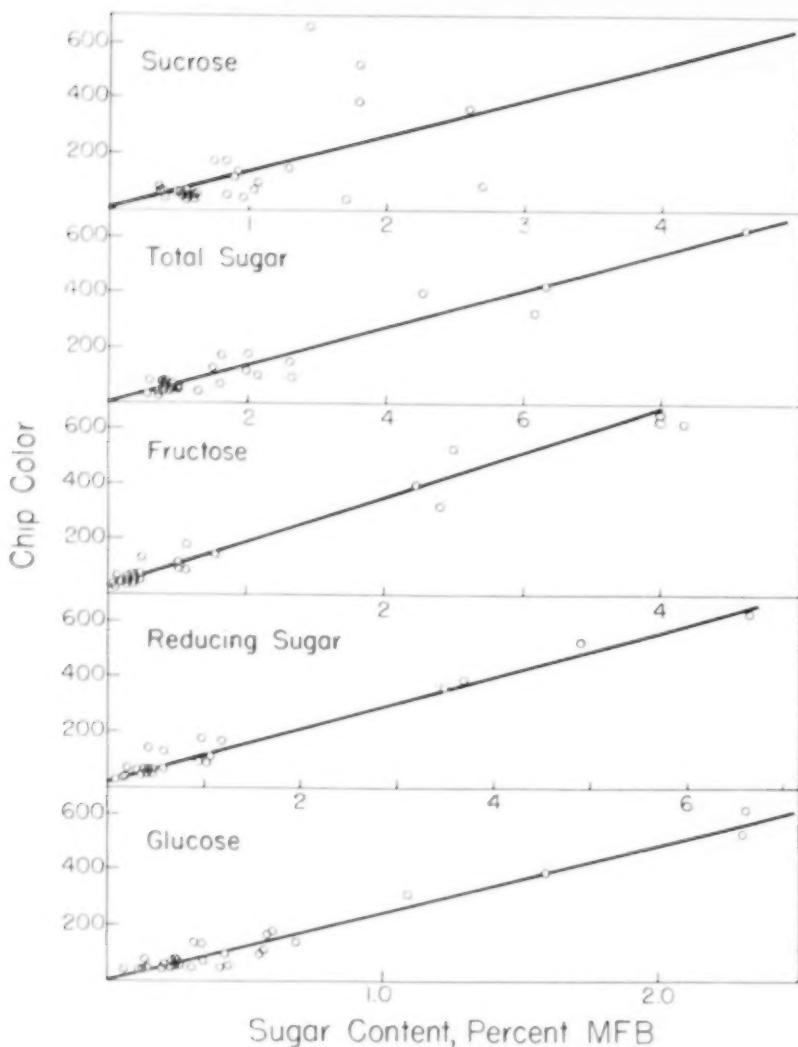


FIGURE 1.—Plot of soluble chip color against the individual sugar content (and combinations thereof) of the raw tuber (western varieties). The straight lines are the calculated lines of regression (See table 5).

any sugar or combination thereof (with the exception of sucrose) listed in table 5 served almost equally well as an index of dice color, with fructose and reducing sugar yielding a slightly smaller $\sigma_{y.x}$ than glucose or total sugar. However, chip color would seem, from table 5, to be a

TABLE 5.—*Statistical data on sugar content of raw tubers vs. color of processed western potatoes.*

Dependent Variable	Statistical Constants ¹				
(x)	sd x	a	b	r	$\sigma_{y.x}$
Chips—Soluble Color					
Glucose	0.63	0	244	0.99	22
Fructose	0.99	36	151	0.97	339
Sucrose	1.60	6	129	0.53	136
Red. Sugar	0.63	22	96	0.99	23
Total Sugar	2.08	-12	71	0.96	44
Dice Browning Rate		93	1.19	0.94	44
Dice—Rate of Browning $\times 10^3$					
Glucose	0.63	5	28	0.92	8
Fructose	0.99	9	18	0.94	7
Sucrose	1.60	8	12	0.41	18
Red. Sugar	0.63	7	11	0.94	7
Total Sugar	2.08	3	8	0.93	8
Chip Color	123	-78	0.84	0.94	4

¹ $y = a + bx$; $a = y$ intercept, $b =$ regression coefficient $sd\ x =$ standard deviation of x ; $r =$ correlation coefficient; $\sigma_{y.x} =$ Standard error of y with respect to x .

better index of browning rate of dice than sugar contents. Plots of browning *vs.* sugar did not display any definite grouping of points with respect to the two western varieties.

That these statistical data demonstrate a similar trend for both processed products is shown in figure 2. Here the y -intercepts ("a") and the regression coefficients ("b") of the chips (data of table 5) are plotted against the corresponding constants for dice. The "a" values decreased in the order: Fructose reducing sugars, glucose total sugar; and "b" values in the order: glucose, fructose, reducing sugar, and total sugar.

To learn whether or not sugar contents could be made to serve as a more reliable index of dice browning rate, sugar analyses were performed on dehydrated dice and compared statistically with rate of browning of the dice. The data of table 6 (as compared with those in table 5) demonstrate that use of sugar values of western varieties of dehydrated dice did not increase the reliability of sugar values as a measure of browning rate, in comparison with similar statistical values obtained with raw-tuber data. Table 6 also tabulates the statistical constants relating reducing sugar contents of Maine and western varieties to browning rate of dehydrated dice prepared from them. Apparently reflecting the smaller range of sugar values, a relatively low correlation coefficient ($r = 0.90$) was obtained from the Maine tubers. On the other hand, the values of the standard error of estimate ($\sigma_{y.x}$) were significantly lower than those for western tubers based upon reducing-sugar content of either raw tuber or dehydrated dice.

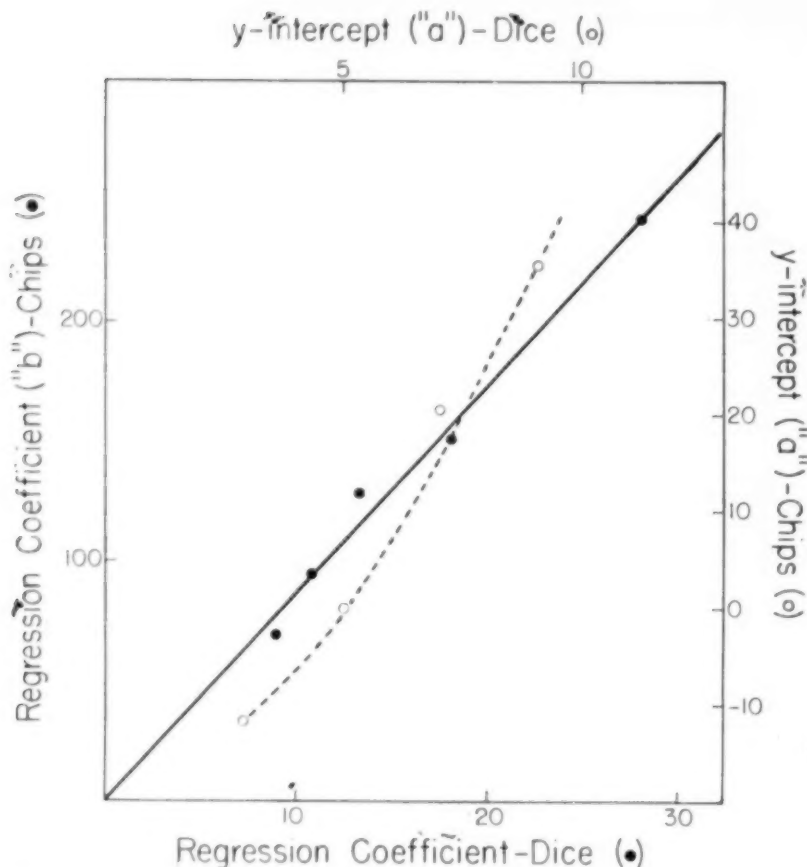


FIGURE 2.—Interrelation among the statistical constants of the regression line relating chip and dice color to potato sugar content (See table 5).

The "Discriminatory Index" (DI). Since the values for $\sigma_{y,x}$ are expressed in terms of essentially non-comparable units, it is rather difficult to compare the results for chips and dice on the basis of this statistical parameter. One approach to such an intercomparison would be to define a "discriminatory index" (DI) as:

$$DI = \frac{R_1}{\sigma_{y,x}},$$

where R_1 is the range of values over the samples studied. In the present cases these ranges are 600 color units for chip color and 100 units for dice browning rate. One can then visualize this range as divided into a series of segments. The size of each segment ($\sigma_{y,x}$) will depend upon

TABLE 6.—*Statistical data on sugar contents of tuber and of dehydrated dice vs. browning rate of the dice.*

Varieties	Condition of Potato	Sugar	No. of Samples	a	b	SDx	r	$\sigma_{y,x}$
Western	Dehydrated	Glucose	24	8.3	24.7	0.69	0.84	11.4
"	"	Fructose	24	6.0	17.8	1.08	0.94	7.2
"	"	Sucrose	24	-3.9	19.2	0.77	0.72	14.4
"	"	Red. Sugars	24	6.7	10.6	1.75	0.91	8.6
"	"	Total Sugar	24	0.4	7.8	2.37	0.83	8.6
"	Raw	Reducing	27	7.1	11.3	1.61	0.94	6.8
Maine	Raw	Red. Sugar	14	7.0	9.7	0.73	0.90	3.6
Maine + Western	Raw	Red. Sugar	41	6.6	11.2	1.34	0.93	6.2

both the nature of the unitage system and the reliability of the measurement, whereas the number of segments (DI, a dimensionless quantity) will depend only on the "discriminatory" or resolving power of the measurements being used as an index of browning. This parameter is related to the "sensitivity" statistic recently developed by Mandel and Stiehler (9). Table 7 shows values of DI to the nearest integer over the entire color range studied (R_1) for both dice and chips. It will be noted that for $R_1 = R_1'$ glucose and reducing sugar constitute more sensitive criteria of chip color than of dice color, whereas fructose and total sugar serve as equally comparable indices (but at a lower level of sensitivity) of both chips and dice. Finally, and possibly most significant from a practical point of view, is the observation that chip color constitutes a more sensitive index of dice browning rate than any one of the sugar components or combinations thereof.

TABLE 7.—*Application of the "Discriminatory Index" to measured variables over entire color range (R_1') and limited color range (R_1'').*

Dependent Variable Measured	Discriminatory Index			
	Range = R_1'		Range = R_1''	
	Chips	Dice	Chips	Dice
Glucose	27	12	9.7	3.8
Fructose	15	14	5.5	4.3
Sucrose	4	5	1.6	1.7
Reducing Sugar	26	14	9.3	4.3
Total Sugar	14	12	4.9	4.7
Dice Browning Rate	14		4.9	
Chip Color		25		7.5

It is perhaps more instructive to determine DI values within a narrower range, including only those points one might expect to meet in practice. Thus we may select a value of 2.0 per cent reducing sugar as covering the restricted range of interest, since in commercial practice one very seldom finds higher values. For chips, this reducing-sugar value would correspond to R_1 equal to 213 chip color units and to a browning rate equal to 39 units as obtained from the respective calculated regression lines. DI values for these limited ranges are also shown in table 7 (R_1'').

Here we see the strict unreliability of sucrose as a measure of browning, since a DI value less than 2 would not permit even a qualitative estimate of browning to be made. An intercomparison of these values yields the following conclusions: (a) glucose and reducing-sugar determinations measure chip color twice as reliably as they measure dice browning rate; (b) these two sugar measurements constitute indices of chip color which are about twice as reliable as are fructose, total sugar, or dice browning rate; (c) with the exception of sucrose, each sugar or combination thereof serves equally well as an index of dice browning rate; and (d) chip color is a better index of browning rate than any sugar or combination thereof.

Kinetics of Accelerated Browning of Dehydrated Potato Dice. Figure 3 shows the course of browning for several lots of Katahdin potatoes, assorted according to specific gravity. It will be noted that within the experimental error of the method, a linear relation exists between optical density and time of heat damage at 50°C. It will also be noted, incidentally, that the browning rates are greater for the dice derived from low-specific-gravity tubers. Linearity with respect to time was found to hold for the western varieties used in these and in previously reported studies (4,7). On the other hand, the course of browning of dice from the Green Mountain potatoes shows a definite induction period as shown in figure 4.

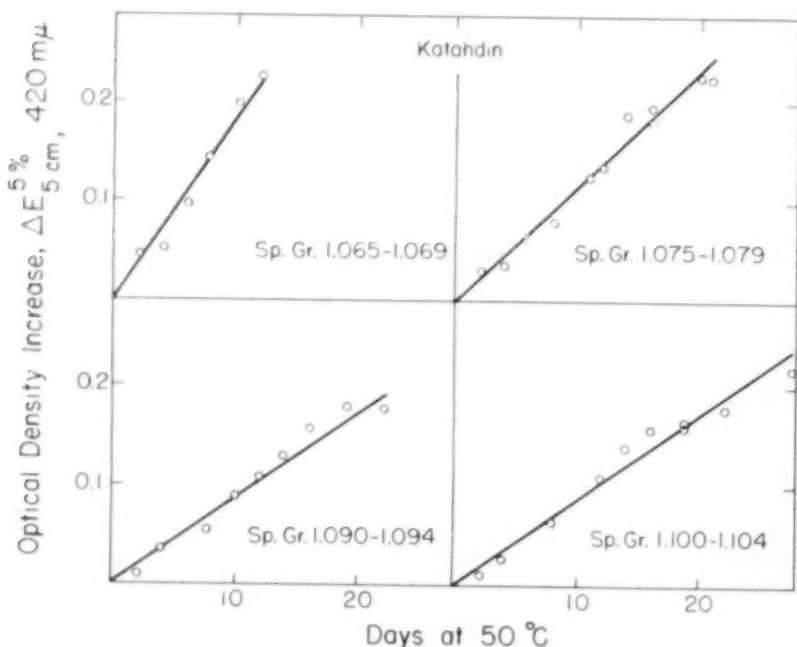


FIGURE 3.—Increase in optical density of extract from Katahdin dehydrated diced potato with time, illustrating the linear nature of the course of the browning reaction.

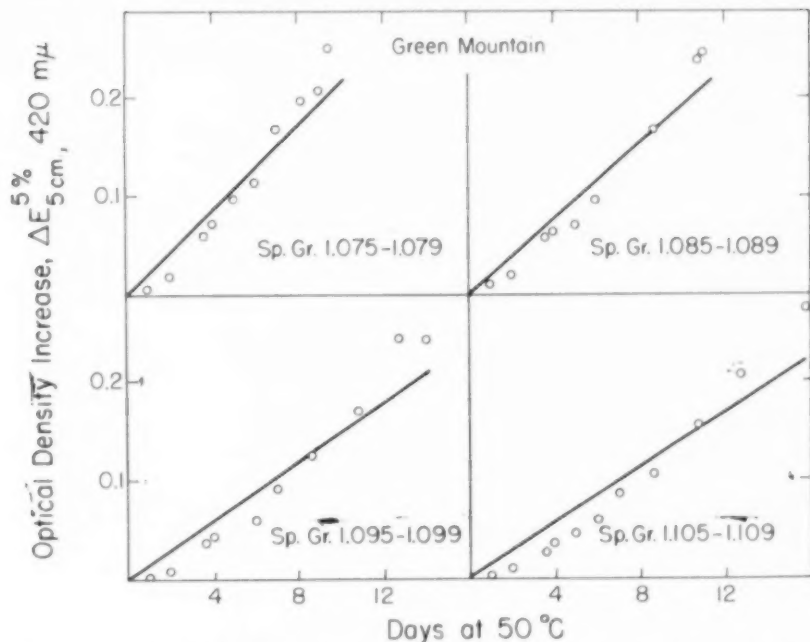


FIGURE 4.—Increase in optical density of extract from Green Mountain dehydrated diced potato with time, illustrating deviation from linearity of the course of the browning reaction.

To limit ourselves to a useful range of values, an optical density increase of 50 units was used in determining the browning rate. This rate was taken as the slope of the straight line from the origin through the points from browning of 50 units optical density increase. Such a range was selected in a previous publication (7) on the assumption that it may approximate the range of commercial interest. Browning corresponding to this average rate did not differ greatly from the observed browning during the stage of the reaction within this range.

This procedure is considered valid when the deviation from linearity is not very marked as is the case with non-sulfited potato dice. For the cases where the deviation is marked, as when sulfite is present, this procedure would result in considerable error at certain stages of browning; for such cases the procedure used in a previous correlation (6) with sulfited dried vegetables is considered preferable, the reciprocals of the lengths of time for given amounts of browning being taken as the average rates of browning. This procedure was first used by Stadtman *et al.* (18) with sulfited dried apricots.

DISCUSSION

Inspection of the results described herein reveals that although there is a fair degree of statistical interaction (as indicated by the conventional appraisal) among the measured variables (with the exception of sucrose),

the reliability of a single measurement, as evidenced by the "discriminatory index", leaves much to be desired in attempting to place the browning-sugar relation on a firm causal basis.

With this viewpoint in mind, let us consider the various factors which might be responsible for variability as enumerated in the Introduction. (a) Extraction and clarification procedures can be eliminated as a source of variability, since these procedures have been shown to recover the sugars quantitatively (14, 19). (b) The estimates of color are based upon carefully worked out procedures for measuring soluble brown color. It is true that the scatter at a high sugar content may be due to inability to measure total color. But elimination of these points by use of a "limited range of interest," R_1'' , table 7, reveals that scatter is still appreciable. (c) Deionization procedures have been shown to eliminate all possible ionic interferers (14). Furthermore, recent sugar analyses on both deionized and undeionized extracts yielded almost identical values as revealed in unpublished results. (d) Although glucose and fructose may apparently contribute to the browning to different extents as revealed here and in model browning systems (14, 15), this discrepancy cannot be the sole factor leading to scatter, since no measurement of fructose or glucose alone was significantly more reliable than the overall reducing sugar content. (e) Although the sugar content of the dice was significantly different from that of the raw tuber, no improvement in the reliability of sugars as a measure of browning rate could be detected. We can therefore eliminate this factor. (f) Variations in total and amino nitrogen were not great enough to be interpreted in terms of variations of browning susceptibility. These values, especially for the Maine potatoes, were characteristic of variety only and were fairly constant with respect to storage temperature.

Although these amino groups are most probably involved in browning (1, 10), under our conditions apparent inability of variations in the level of these groups to reflect corresponding changes in browning may be, at least in part, ascribed to their presence in non-rate-limiting concentrations. Thus it has been calculated that, on the average, the relative molar equivalent concentration of amino nitrogen in potatoes is about 5 times that of the average molar equivalent reducing-sugar concentration. Roughly, it has been estimated that, at this average level of amino nitrogen in the samples herein reported, a 5-fold excess of the latter over reducing sugar in potatoes would correspond to the very low level of reducing sugar of the order of 0.05 per cent (MFB).

We must therefore conclude (g) that unmeasured variations in the levels of other direct or possibly indirect factors (as mentioned in the Introduction) contribute to the formation of soluble brown color. If speculations may be permitted, it may be mentioned that organic acids (18) have been implicated in the non-enzymatic browning of fruits, and that metals (2) and phosphate ion (15) profoundly influence rate of non-enzymatic browning. The implication of phosphate in non-enzymatic browning is in agreement with its detection in appreciable amounts in potatoes (12, 13, 16) and also may serve to explain, in part, recent observations on the decrease in browning of dehydrated dice treated with calcium chloride previous to dehydration (17). Again using average values, it has been estimated that the total equivalents of phosphorus potentially available as inorganic phosphate are roughly the same as the average of

the equivalents of reducing sugar. Hence there is enough phosphorus available to account for such an effect.

It indeed is not surprising that the chip color constitutes a more reliable index of browning rate of dice than does sugar measurements, since chip color probably represents more closely the resultant effect of the complex factors influencing the Maillard-type reaction in potatoes than does any particular sugar value. The DI value (equal to 7.5) for chips as a measure of dice browning rate within the limited R_1'' of table 7 would indicate that any other measurement which can resolve dice color into at least 8 significance intervals would be at least equally as valid as a measure of dice browning rate. Subjective observation of chip color, especially in comparison with appropriate graded color standards, can probably discriminate among at least 8 graduations. Such subjective tests *e.g.*, see Wright, 21) therefore may constitute as valid a test as any of the more elaborate measurements described herein.

The fact that the plots of accelerated browning *vs.* time were essentially and consistently linear for certain lots of potatoes but consistently curved upwards for other lots, as shown in figures 5 and 6, is evidence that the indicated difference in the shape of the plots is real and not the result of experimental uncertainty. It also indicates that the course of browning (or the relative importance of various contributing reactions) may be different in different lots of potatoes.

SUMMARY

A principal factor in assessment of quality of processed potato products is the Maillard-reaction-induced brown color which develops during processing (chips) or during subsequent storage (dehydrated dice). The present paper constitutes a statistical appraisal of the relationship between this browning and the individual reducing-sugar components of the raw tubers and dehydrated potato dice. Although correlation coefficients were greater than 0.9 (except for sucrose) comparison of standard errors of estimate and application of a parameter referred to herein as the "discriminatory index" reveals that sugar measurements, or combinations thereof, do not yield sufficient information to establish an exclusively complete causal relationship between reducing sugar components and extent and rate of browning. This is true despite the control or elimination of several factors usually overlooked in the pertinent measurements which might lead to the observed scatter. Possible auxiliary factors operating during the browning reaction, other than sugars and amino compounds, are discussed. Application of discriminatory indices to the data reveals reducing-sugar and glucose measurements as a more sensitive index of browning in potato chips than of browning rate of dehydrated potato dice. On the other hand, measurements of fructose and total sugar constitute equally reliable indices of both types of browning but at a lower sensitivity level. From the standpoint of prediction of quality of processed potato products in general, this analysis leads to the conclusion that subjective or semiquantitative appraisal of chip color may constitute at least as adequate an index of quality as any of the more elaborate objective measurements undertaken in the laboratory.

LITERATURE CITED

1. Anderton, J. F. 1953. The non-enzymic browning of food products. Scientific and Technical Surveys No. 21. The British Food Manufacturing Industries Association, 1-82.
2. Bobart, G. S., and J. F. Carson. 1955. Effects of trace metals, oxygen, and light on the glucose-glycine browning reaction. *Nature* 175: 470-471.
3. Hendel, C. E., G. F. Bailey, and D. H. Taylor. 1950. Measurement of non-enzymatic browning of dehydrated vegetables during storage. *Food Tech.* 4: 344-347.
4. ———, V. G. Silveira, and W. O. Harrington. 1954. Rates of non-enzymatic browning of white potato. Abs. 14th Ann. Meeting, Ins. Food Tech. 8: 27.
5. Hodge, J. W. 1953. Chemistry of browning reaction in model systems. *Jour. Agr. Food Chem.* 1: 928-943.
6. Legault, R. R., C. E. Hendel, W. F. Talburt, and M. F. Pool. 1951. Browning of dehydrated sulfited vegetables during storage. *Food Tech.* 5: 417-423.
7. ———, W. F. Talburt, A. M. Mylne, and L. A. Bryan. 1947. Browning of dehydrated vegetables during storage. *Ind. Eng. Chem.* 39: 1294-1299.
8. Makower, B., S. M. Chastain, and E. Nielson. 1946. Moisture determination in dehydrated vegetables. Vacuum oven method. *Ind. Eng. Chem.* 38: 725-731.
9. Mandel, J., and R. D. Stiehler. 1954. Sensitivity—a criterion for the comparison of methods of test. *Jour. Res. Nat. Bur. Standards.* 53: 155-159.
10. Patton, A. R., and W. E. Pyke. 1946. The role of amino acids and glucose in the browning of potato chips and dehydrated potatoes. Abstracts, 110th Amer. Meeting, Amer. Chem. Soc. 10A.
11. Ross, A. F. 1948. Deterioration of processed potatoes. *Adv. in Food Research*, Academic Press, Inc., New York, N. Y. 1: 257-290.
12. Schwimmer, S. 1953. Enzyme systems of the white potato. *Jour. Agr. Food Chem.* 1: 1063-1069.
13. ———, A. Bevenue, and W. J. Weston. 1955. Potato composition. Phosphorus components of the white potato. *Jour. Agr. Food Chem.* 3: 257-260.
14. ———, ———, and A. L. Potter. 1954. Potato composition. Survey of major and minor sugar and starch components of the white potato. *Jour. Agr. Food Chem.* : 1284-1290.
15. ———, and H. S. Olcott. 1953. Reaction between glycine and the hexose phosphates. *Jour. Amer. Chem. Soc.* 75: 4855-4856.
16. ———, and W. J. Weston. 1956. Effect of phosphate and other factors in potato extracts on amylose formation by phosphorylase. *Jour. Biol. Chem.* 220: 143-155.
17. Simon, M., J. R. Wagner, V. G. Silveira, and C. E. Hendel. 1955. Calcium chloride as a non-enzymic browning retardant for dehydrated white potatoes. *Food Tech.* 9: 271-275.
18. Stadtman, E. R. 1948. Non-enzymatic browning in fruit products. *Advances in Food Research*, Academic Press, Inc., New York, N. Y. 1: 325-369.
19. Williams, K. T., A. Bevenue, and B. Washauer. 1950. A study of the use of ion-exchange resins for the removal of non-sugar reducing substances in the analysis of fresh and dehydrated vegetables for reducing sugars. *J. Assoc. Offic. Agr. Chem.* 33: 986-994.
20. ———, and E. A. McComb. 1951. A rapid method for the determination of oil in potato chips. *Potato Chipper* 10: 5-6.
21. Wright, R. C. 1954. Chipping quality of eight potato varieties as affected by source and by storage treatment. *Circ. No. 936. U. S. Dept. of Agr.*

SURVIVAL OF THE RING-ROT BACTERIA IN WET POTATO PULP FROM THE STARCH FACTORIES¹REINER BONDE AND J. S. GETCHELL²

It has long been the practice in Maine to deposit the pulp and other waste materials from the potato starch factories into the local streams and rivers. The recent efforts of the State Fish and Game Commission to prevent the pollution of our streams and waterways have made it necessary to find other means of disposing of this waste material. It would be highly desirable if the potato pulp from the starch factories could be utilized in a profitable manner.

In Europe cull potatoes and the wet pulp from the starch factories have been used as feed for farm animals for many years. Experiments conducted in Maine show that it may be an economical food for cattle, sheep, and possibly other kinds of livestock (1-4). Starch factories, however, normally utilize chiefly poor quality potatoes many lots of which may contain tubers that have the bacterial ring-rot disease. The ring-rot bacteria in these diseased potatoes are very infectious and may be a source of contamination of healthy seed potatoes. It is highly important to learn if the ring-rot bacteria will survive in the potato pulp and be a source of infection to the healthy potatoes grown in Aroostook County.

Experiments were conducted during 1956 to obtain information on the period of time that the ring-rot bacteria can remain viable and infectious in wet pulp.

A 100-pound sample of freshly prepared potato pulp obtained from the Presque Isle Potato Starch Company was used for one of these experiments. This sample was taken at random and its ring-rot content was not known until some time later. The pulp was divided into approximately equal portions which were put into several large porcelain clay jars which were stored for different periods of time, some in one bin maintained at 40°F. and the others in another bin maintained at temperatures that varied from 50 to 55°F.

The untreated factory pulp tested for pathogenicity by using it to inoculate freshly cut healthy potato seed pieces after the pulp had been in the respective storage temperatures for periods of time that varied from 0 to 28 days. Table 1 shows the percentages of ring-rot infected plants that resulted. The pulp, when taken from the starch factory, caused 12 to 15 per cent infection. Infectiveness, however, was lost in five days when the pulp was stored at 50 to 55°F. The 40°F. storage was more favorable for the persistence of infectiveness, since here the pulp was still infectious at 5 days and more. No infection occurred after 7 days of storage.

Macerated potato tissue from ring-rot infected tubers was added to two batches of the same factory pulp to insure that pathogenic bacteria were present in the pulp before it was placed in the respective storage temperatures. The data in columns 4 and 5 in table 1 show the percentage of ring-rot infection that occurred when this infected pulp was tested. This pulp was more infectious than that to which no inoculum had been added.

¹Accepted for publication January 18, 1957.

²Plant Pathologist and Associate Food Technologist, Maine Agricultural Experiment Station, University of Maine, Orono, Maine.

TABLE 1.—*Percentage of ring-rot infection in plants grown from seed pieces inoculated with pulp from starch factory.*¹

Days Pulp Was Stored before Used to Inoculate	Infection from Inoculations ²			
	No Ring-rot Pulp Added		Ring-rot Pulp Added to Factory Pulp ³	
	40° F.	50-55° F.	40° F.	50-55° F.
Used Immediately ..	<i>Per cent</i> 12	<i>Per cent</i> 15	<i>Per cent</i> 98	<i>Per cent</i> 100
5	24	0	—	—
7	0	0	29	9
14	0	0	0	1
21	0	0	0	0
28	0	0	0	0

¹Pulp was taken directly from the "shaker screen" in the starch factory after the starch had been removed by washing.

²Each percentage of infection was based on plants grown from 100 freshly-cut seed pieces inoculated by being dipped in a water slurry made from a sample of pulp.

³Approximately five pounds of pulp from diseased tubers were added to 50 pounds of pulp taken from factory.

It produced nearly 100 per cent infection when used before storage to inoculate healthy potato seed pieces. The infectiveness of the pulp, however, was rapidly lost when stored. It caused only 29 per cent infection after storage at 40° F. for 7 days and 9 per cent infection when stored at 50 to 55° F. for the same period. Further the infectiveness was entirely lost within 14 days at 40° F. and within 21 days at 50 to 55° F.

In another experiment pulp was prepared in a laboratory at Orono by grinding 50 pounds of healthy tubers and 5 pounds of ring-rot infected Katahdin tubers together with a hammer mill. The pulp was thoroughly washed to remove the starch before being put into porcelain clay jars and stored at 40° F. and at 50-55° F. as in the first experiment. Samples of the two batches of stored pulp were taken at successive intervals and diluted in water to make a thick slurry in which freshly cut Katahdin seed pieces were "dip inoculated" before being planted in the field.

Table 2 gives the percentage of ring-rot infected plants that resulted. The data show that the inoculated pulp was highly infectious before being placed in storage even though it had been thoroughly washed to remove the starch. However, practically no infection occurred after the pulp had been stored for more than 3 days. The infected pulp lost its infectiveness more rapidly at the higher storage temperature. The fermentation process was more active at the 50-55° F. temperature range than at 40° F.

The results of these experiments show that apparently any ring-rot bacteria in wet potato pulp from the starch factory will mostly die after a period of 3 to 7 days and that a few may remain alive for as long as 17 days in storage at 40° F. A storage temperature of 50-55° F. was less favorable for the survival of the bacteria than 40° F.

The data derived from these experiments are in agreement with information obtained in Maine in 1943 which showed that the ring-rot bacteria survived in macerated diseased tubers for a period of less than 13 days. Furthermore no ring-rot infection was obtained from badly decayed tubers (5) in the 1943 studies.

TABLE 2.—Percentage of ring-rot infection in plants grown from seed pieces inoculated with potato pulp produced in a laboratory.¹

Days Pulp Was Stored before Used to Inoculate	Infection of Plants from Inoculations ²	
	40°F.	50-55°F.
	<i>Per cent</i>	<i>Per cent</i>
Used Immediately	82	85
1	64	39
3	9	4
9	0	0
17	2	0
23	0	0

¹Pulp made by grinding 50 pounds of healthy and 5 pounds of ring-rot infected Katahdin potato tubers together in a hammer mill in the laboratory followed by thorough washing to remove the starch.

²Each percentage of infection was based on plants grown from 100 freshly cut potato seed pieces inoculated by being dipped in a water slurry made from a sample of the pulp.

In other experiments in 1943 the bacteria died rapidly on moldy burlap bags in a commercial storage bin but remained alive for 9 months or more when the bags were free from mold. The bacteria also survived the winter on mold-free burlap sacks exposed to the extreme outdoor temperatures of Aroostook County, Maine (unpublished information). We do not know how long the bacteria will survive in frozen potato pulp. However, the bacteria would not survive in dried potato pulp if it has been heat-treated in the process of being manufactured, because this treatment raises the pulp to a relatively high temperature.

The bacteria may remain alive on contaminated barrels and other containers used in carrying the pulp from the factory to the farm unless disinfectants are used. Experiments conducted in Maine and elsewhere have shown that the bacteria soon die when present in unsterilized soil.

LITERATURE CITED

- Corbett, Ralph A. 1956. Dairyman—Are you feeding dried potato pulp? Maine Ext. Serv. Circ. 307.
- Dickey, Howard C. 1955. Dried potato pulp for dairy cattle. Maine Agr. Exp. Sta. Bull. 539.
- . 1955. Potato pulp is a new dairy feed. Maine Farm Research, January.
- Douglass, Irwin B. and Howard C. Dickey. Questions and answers concerning dried potato pulp and other feed products. Mimeo Dept., Univ. of Maine.
- Snieszko, S. F. and Reiner Bonde. 1943. Studies on the morphology, physiology, serology, longevity, and pathogenicity of *Corynebacterium sepedanicum*. Phytopath. 33: 1032-1044.

RED DOT FOODS, INC. AND ITS POTATO RESEARCH PROGRAM¹F. J. STEVENSON²

ORIGIN OF RED DOT

Red Dot Foods, Inc., Madison, Wisconsin, the largest potato chip manufacturing company in the Middle West, and one of the largest in the United States, sustains its own potato research program. This program in itself is interesting, but it is only a small, though important, part of the many activities carried on by the company, the founding and development of which is one of the most romantic and fascinating stories of the past 25 years.

The story of Red Dot and the Red Dot label on packages of potato chips and other snack foods is quite familiar to many people throughout the Middle West and to some of the readers of the American Potato Journal, of which the company is a sustaining member; but to other readers of this Journal a brief account of the origin of the company, what it is today, and a report of its research program should be of special interest.

The Red Dot story has been told in many newspaper articles, but is best told in an article in *Chip Chat*³ entitled, "25 Years of Opportunity, the History of Red Dot Foods, Inc.". As one reads this article he is soon aware that it is not the history of a large, soulless, successful business organization, but of 25 years of the lives of two remarkable people; Frederick J. (Fred) Meyer (Figure 1) and his wife Kathryne (Kaye) founders and co-owners of the company and now President and Secretary-Treasurer, respectively.

Fred and Kaye attended the University of Wisconsin when the depression was at its worst, he majoring in Chemistry and she in Commerce. They were married in their Junior year and it was logical that Fred should quit the University, get a job, and support his new household. However, he and Kaye were determined to graduate from the University. They would find a way to support themselves and at the same time continue their education. They rented a tiny apartment furnished with cast-offs and set out to meet an unpromising future in that depression year of 1931.

Meyer was familiar with selling food because of his boyhood years of experience in his father's general store at West Salem, Wisconsin, and this experience he used now to advantage. He needed a product he could sell at a profit during the summer months of 1931 so that both he and his wife could attend the University in the fall. They answered about 30 advertisements found in a magazine known as "Opportunity." The most attractive deal was on a salted confection called Korn Patchies. Meyer

¹Accepted for publication January 10, 1957.

²Formerly, Geneticist, U.S.D.A.; retired and now geneticist for Red Dot Foods, Inc., Madison, Wis.

³*Chip Chat*, A magazine of, by and for employees and friends of Red Dot Foods, Inc. The article cited and drawn on rather extensively in this paper was written by Margaret (Peg) Thoma, editor of the magazine from its inception.



FIGURE 1.—Frederick J. Meyer, President, Red Dot Foods, Inc. Nearly 10 years ago he started the search for a potato specifically bred for chipping.

invested \$22.00 for 3 cases of this item. When the merchandise came he put it in his car and set out to sell it. He was successful from the start and soon added potato chips manufactured by Doc Yandre, Lake Mills, to his line. When fall came, Fred and Kaye matriculated for their final year at the University. Fred sold between classes, after classes and on Saturdays. Kaye kept the books of a student publishing company, kept house and did the stenographic work for their business transactions. Their Chevy roadster with its rumble seat was their "wholesale truck".

Despite handicaps, during their last semester they both made the highest grades of their University careers and their theses, his in Chemistry, hers in Commerce, were both rated "excellent".

Graduation Day came and then, *what to do?* Jobs were scarce. Fred was offered a job as a graduate assistant to continue his education for a PhD in Chemistry, but the stipend was smaller than the amount of money he was making selling foods, so he decided to continue with the latter. Shortly after he graduated a fire at Doc Yandre's Lake Mills factory stopped his supply of potato chips. Potato chips were too good an item to discontinue, so Fred bought a small, chip-frying machine for \$50 and started his fabulous career as a manufacturer of potato chips.

PRESENT STATUS OF RED DOT

From \$22.00 invested in merchandise, an old Chevy car in which to peddle it, and \$50 paid for the first fryer, the company has grown to

incredible proportions. The fourth installment of the article "25 Years of Opportunity" in the November-December issue of *Chip Chat* gives some idea of the present status of the company. "In December of 1956 the tally of the factories had risen to nine, located in six states; two other factories (one processing nuts, the other manufacturing cookies) are operating as wholly-owned subsidiaries. Our 77 sales branches, service part, or all of 12 states, Red Dot Farms cover 15,000 acres in Alabama and Wisconsin. A handsome, modern greenhouse capable of growing 16,000 potential new varieties has been erected for the winter housing of our potato breeding operations (Figure 2). Over one-half million bushels of potatoes can be stored in our air-controlled potato warehouses located close to potato growing land. A vaning system of 28 vans, completely owned and operated by the company, ties our factories and sales branches together. Almost 1,000 employees comprise the growing Red Dot Family."

FARMING AND RESEARCH

Most potato chip companies buy their raw materials on the open market; but Red Dot on its many farms in Alabama and Wisconsin, raises about 2500 acres or approximately 50 per cent of the potatoes needed to supply its many factories. To make a success in this department and insure a supply of potatoes that give high quality chips, the company initiated its own research program. This involved the testing of many varieties to find those best adapted to the growing conditions on the various farms; and since the variety is not the entire answer, cultural problems such as fertilizer requirements, rotation of crops, rate of planting of new varieties, time of planting, time of harvest, disease and insect control are investigated simultaneously with the breeding studies.

The breeding work is carried on in cooperation with the United States Department of Agriculture and various state agricultural experiment stations, especially with that of Wisconsin. The potato breeding programs of these institutions have as their goals varieties with higher yields, higher market and cooking qualities, and disease resistance.

These characters are highly desirable in any variety of potato, but early in his work Meyer was convinced that since the potato chip industry was so important, greater effort should be made to breed varieties with superior chip quality. Consequently in 1947 he organized the Red Dot Potato Breeding Program. Wayne W. (Jim) Weber was employed to conduct this research and later was put in charge of all farming operations. Jim was well qualified to head up the potato breeding work. He completed his studies for his PhD in Genetics and Plant Breeding at the University of Wisconsin shortly after he began to work for Red Dot.

It is interesting to note the characteristics of the potato that Weber and Meyer set out to produce:

1. Cooks into a fine light colored chip directly from cold storage, or with a minimum warm-up time.
2. Round, smooth with shallow eyes so it will peel evenly in the automatic peelers.
3. Absorb a minimum of oil in the cooking process.
4. Consistently and predictably cooks to a uniform color.
5. A good commercial potato, with high yield, disease-resistance and possessing good flavor.

They knew it might take years to produce such an ideal potato, but that was all the greater reason for getting the program underway.

Over the years many named and seedling varieties were tested in cooperation with the U.S.D.A., the Wisconsin Agricultural Experiment Station and a number of other state experiment stations.

As a result of these tests a few varieties were found that have met the needs of the company to a greater extent than the old standard varieties; for example, Kennebec grown in Northern Wisconsin and Sebago and Russet Sebago in Alabama. However, these have certain undesirable characteristics that make them far from ideal and the plant breeding program must continue.

PLANT PATHOLOGY, CULTURE AND STORAGE

In 1953 Edward D. Jones, who received a PhD in Plant Pathology at the University of Wisconsin, was added to the Red Dot Research Staff. His activities have been numerous and sundry. He manages the operation of the Research Farm. He grows foundation seed for the commercial farming operations. His research problems cover a wide range of interests involving plant diseases and insects and their control; cultural methods such as rate of planting, crop rotations, and rate and time of application of various fertilizers. He tests new varieties and seedlings for yield, specific gravity, sugar content, chip quality and other characters. He investigates various phases of the storage of potatoes, with tests of rest period, and the effectiveness of certain chemicals, and of irradiation as sprout inhibitors and their effects on chip quality.

POTATO BREEDING PROGRAM EXPANDED

In 1956 the Red Dot Potato Breeding Program was further expanded. The writer, who was leader of the National Potato Breeding Program of the U.S.D.A. for nearly 26 years, was asked to join Red Dot and direct its potato breeding activities. The objectives that Weber and Meyer set up in 1943 are still adequate as the basis of a good program. The prime objective is still the production of new varieties with higher chip quality than any that are now being used; and since Red Dot grows such large crops of potatoes other characters such as season of maturity, yield, percentage of total solids, tuber shape, depth of eye, keeping quality and resistance to the most troublesome diseases must always be emphasized.

The field work is done in the summer on the Red Dot Research Farm, Rhinelander; and a new greenhouse, built on the company's Fair Oaks property in Madison, houses the seedlings in the late summer and fall (Figures 3 & 4). In the winter and spring the parents will be grown and the new crosses made.

SOME RESULTS OF AN ENLARGED PROGRAM

In 1955 Jones visited Presque Isle, Maine at harvest time and brought back to Wisconsin 236 selections produced under the National Potato Breeding Program. These had been selected for tuber shape and apparent yielding ability, and tested over various periods of years for season of maturity, fertility, specific gravity and reactions to a number of diseases.

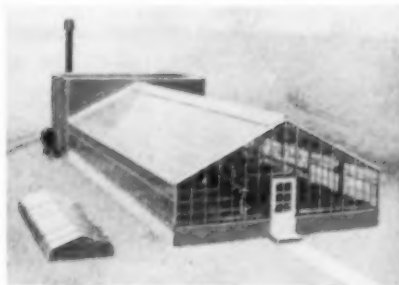


FIGURE 2.



FIGURE 3.



FIGURE 4.



FIGURE 5.

FIGURE 2.—Red Dot's new research greenhouse. Box at lower left is a soil treatment pit. The facility enables the breeding program to operate on a year-around basis.

FIGURE 3.—An interior view of the greenhouse finds "Steve" (F. J. Stevenson) caring for his 16,500 babies. Note snow on ground through greenhouse windows.

FIGURE 4.—Dr. F. J. Stevenson examines the little tubers on a 9 week old plant. There are usually 2 or 3 small tubers under each plant at maturity.

FIGURE 5.—Drs. Stevenson and Jones examining the results of 10 hill rows and recording findings on yield, appearance, freedom from disease, *etc.*, prior to forwarding their selections to the Production Dept. for frying tests.

In 1956 the 236 selections were grown in 10-hill rows on the Red Dot Research Farm. Many of these selections are early-maturing and about 50 per cent of them produced relatively high yields of excellent shaped tubers and were saved for the 1957 tests (Figure 5).

A number of these showed satisfactory specific gravity and excellent chip quality when cooked before being placed in cold storage; and at the time this article is being written other samples of the same seedlings are in cold storage where they will remain for several weeks, after which they will be reconditioned and re-tested for chip quality.

In the spring of 1956 about 7,000 seedlings representing 47 family lines, obtained from the greenhouse of the Plant Industry Station, Beltsville, Maryland were planted on the Red Dot Research Farm. Ninety-seven per cent of the tubers germinated. Weather conditions were favorable and an excellent crop was produced. 488 selections were made on the basis of tuber shape and apparent yielding ability. Samples of each of these are now in cold storage (38°F.) at the East Washington Avenue plant; where after approximately 4 months in storage they will be tested for their reconditioning behavior and chip quality. A total of 814 selections from 9 progenies will be tested in a similar manner to determine the crosses that produce the highest percentage of seedlings with satisfactory reconditioning and chipping qualities.

In 1957 all selections will be grown in larger plots on the Red Dot Research Farm and tested again for their reactions to storage conditions and their chipping quality. A study will be made of the correlation between the results obtained from first year seedlings grown in single hills; and the results from the same seedlings grown the second year in larger plots.

GREENHOUSE SEEDLINGS

About 16,000 seedlings representing 59 family lines are now growing in the new greenhouse at Madison. A number of these lines will be tested for chip quality or for sugars by the picric acid test. The same seedlings will be planted in Rhineland and tested again for chip quality in an attempt to ascertain whether or not results from greenhouse material give a reliable index of results to expect from field-grown stock.

CONCLUSION

The potato breeder has many hereditary characters with which to work and it should not be long before new varieties, with superior chip quality, will replace in whole, or in part, the varieties that are grown today to supply the many factories owned and operated by Red Dot Foods, Inc.

HOW CAN WE INTERPRET THE ZERO TOLERANCE FOR BACTERIAL RING ROT IN CERTIFIED SEED POTATOES¹

- C. E. LOGSDON, Alaska Exp. Sta., Palmer, Alaska
H. W. POULSEN, JOHN J. ADAMS, Bur. Fruit and Veg. Standardization, Dept. Agr., Sacramento 14, Cal.
J. W. SCANNELL, Plant Protection Division, Dept. of Agr., Science Service Bldg., Ottawa, Canada
C. W. FRUTCHEY, Colo. A.&M. College, Fort Collins, Colo.
ROBERT HICKMAN, Delaware State Board of Agriculture, Dover, Del.
T. C. BLACKBURN, Idaho Crop Imprv. Assn., Inc., P. O. Box 2601, Boise, Idaho
J. L. ROBINSON, Iowa Crop Imp. Assn., 112 Agronomy Bldg., Ames, Iowa
E. L. NEWDICK, PAUL J. EASTMAN, Division of Plant Industry, Dept of Agr., Augusta, Me.
L. O. WEAVER, Univ. of Maryland, Agr. Exp. Sta., College Park, Md.
H. C. MOORE, Michigan Crop Imp. Assn., Michigan State College, E. Lansing, Mich.
A. G. TOLAAS, Division of Plant Industry, Dept. of Agr., St. Paul Campus, Univ. of Minn., St. Paul 1, Minn.
L. A. YAGER, Mont. State College, Bozeman, Mont.
P. J. HOFF, Potato Seed Cert. Assn. of Nebr., P. O. Box 90, Alliance, Nebr.
C. A. LYON, Dept. of Agr., Concord, N. H.
W. M. CRANSTOWN, Dept. of Agr., Trenton, N. J.
J. T. STOVALL, N. M. Crop Imp. Assn., P. O. Box 425, State College, N. M.
K. H. FERNOW, N. Y. State College of Agr., Ithaca, N. Y.
F. W. McLAUGHLIN, N. C. Crop Imp. Assn., Inc., State College Station, Raleigh, N. C.
R. C. HASTINGS, State Seed Commissioner, College Station, Fargo, N. D.
C. F. CAMPBELL, WM. YOUNT, Bureau of Plant Industry, Dept. of Agr., Harrisburg, Pa.
JOHN NOONAN, S. D. Potato Growers Assn., Watertown, S. D.
H. L. BRUER, 410 State Office Bldg., Nashville, Tenn.
J. W. SCOTT, Division Plant Pest Control, Dept. Agr., Montpelier, Vt.
S. F. GRUBBS, Virginia Crop Imp. Assn., Inc., Blacksburg, Va.
L. W. KING, State Dept. of Agr., Bellingham, Wash.
B. M. DARLING, Dept. of Plant Path., College of Agr., Madison 6, Wis.
C. M. RINCKER, College of Agr., Laramie, Wyo.

Soon after the first reports on the occurrence of potato ring rot in North America in 1931 (1) practically all of the states certifying seed potatoes and the Canadian Department of Agriculture adopted a zero tolerance for this disease. The reasoning back of this action is briefly stated below.

¹Accepted for publication February 20, 1957.

NOTE: The authors are those in charge of potato inspection and certification work in their respective country, state or territory. The present article is based on a first draft prepared by K. H. Fernow together with changes suggested by the other authors. All the authors endorsed the final draft. It was presented as a report to the Certification Committee of the Potato Association of America, accepted by them, and a request made for its publication in the American Potato Journal.

(1) The disease is very destructive, usually causing nearly a complete loss of crop of the plants affected and a disagreeable rot of some of the remaining tubers.

(2) The disease was believed to have been rather recently introduced and not widely established, with many stocks and farms completely free from it.

(3) Early reports of the infectious nature of the disease led to the belief that the presence of a very few infected tubers in a lot of planting stock would soon result in a high percentage of infection in the field, causing a heavy loss and making detection easy.

(4) It was hoped that the early elimination of slightly infected lots might result in almost complete eradication of the disease from the seed-producing areas.

(5) It was recognized that great difficulty might be experienced in establishing the percentage of infection for application of a tolerance greater than zero.

Some twenty years of experience with the zero tolerance and with the disease, have demonstrated that only the first and last of these assumptions have any considerable measure of validity. This is perhaps, enough to warrant retention of the zero tolerance for the time being. However, there has been widespread misunderstanding as to what can be expected from inspection to a zero tolerance. It is the primary purpose of this article to remove these misunderstandings.

DIFFICULTY OF DETECTION OF SMALL PERCENTAGES

Inspections of potato fields usually do not involve the examination of every plant in the field, nor in the case of tuber inspections, of every tuber in the lot. Regardless of how selected, inspection is by sample. In the case of the inspection of a sample of 1000 plants from a ten acre field, less than 1 per cent of the 150,000 or more plants in the field are examined. Assuming that all infected plants are recognized and that the disease is distributed in a random manner, the odds for and against detection with different percentages of disease and with two sizes of sample are as follows:

<i>Per cent Present</i>	<i>1,000 Plant Sample</i>	<i>10,000 Plant Sample</i>
1.0	23,000 to 1 for	Infinity for
0.1	2 to 1 for	23,000 to 1 for
0.01	10 to 1 against	2 to 1 for
0.001	100 to 1 against	10 to 1 against

For practical purposes it would appear that the discovery level is between one hundredth and one tenth of one per cent.

CONDITIONS SOMETIMES ADVERSE TO DETECTION

In the paragraph above, the assumption was made that the inspection would be conducted under favorable conditions, symptoms plainly visible on all infected plants and distribution of plants uniform over the field. In practice it is doubtful if symptoms are ever plainly visible on more than half of the infected plants and distribution of infected plants is likely to be irregular, due to the infected tubers from a single hill tending to get

into the same bag and to inoculation of successive pieces by cutting knife and planter. Both these factors operate adversely on the probability of detection. If inspection is made before the plants are 95 days old, identification may be more difficult. Plants grown from inoculated tubers may show no symptoms the first year. (2)

The chances of detection of low percentages can be improved somewhat by the examination of more plants, and the selection of suitable times and increasing the number of inspections, but it will never be possible to guarantee freedom from ring rot by a feasible inspection system. Even if the sample size is extended to include every plant, there still exists the possibility that infected plants are not showing symptoms. The same considerations apply to inspections of tubers.

TOLERANCE LEVEL NOT A MEASURE OF SERIOUSNESS

It has sometimes been stated that the inclusion of a zero tolerance for ring rot indicates that it is a very serious disease. We do not wish to minimize the seriousness of the disease but would point out that the selection of a tolerance is often dictated by considerations other than seriousness of the disease. Convenience and practicability are such considerations. With a zero tolerance the discovery of a single infected plant or tuber determines the status of the field for both inspector and seed grower. If the tolerance were set at 0.1 per cent the inspector would have to continue inspection until he had definitely determined whether the percentage of visibly infected plants was above or below this level. The additional labor would have little practical value, since the percentage of visible infections might bear small relation to the total percentage or to the percentage of visible infection at a later date or to the percentage which might result from the planting of the seed the following year. The zero tolerance may then be taken as a somewhat more convenient method of eliminating fields containing more than about 0.1 per cent than would be the case if the actual tolerance were set at 0.1 per cent. However, this is only an approximation. It must be understood that some fields which pass may contain more than 0.1 per cent while some are rejected which contain considerably less.

RATE OF SPREAD NOT ALWAYS HIGH

A question of much importance is: "How rapidly will the ring rot percentage increase from one year to the next?" Unfortunately no simple conclusive answer can be given to this question. Early in the history of ring rot in North America, cases were reported in which severe damage had resulted from the planting of seed thought to contain little or no ring rot. Occasionally such cases still occur. It was assumed that these cases were the result of rapid spread of disease by the cutting knife and other mechanical means. But it is usually impossible to verify such assumptions and it may be suspected that sometimes the original percentage was higher than supposed. It is also evident that the rate of increase varies markedly with the farm where planted. Instances have been noted where the same seed planted on two farms may show serious infestation in one case and in another case a scarcely detectable amount or even none at all. It is assumed these differences are due to sanitary factors but the factors involved often

can be only surmised. Factors which are thought likely to favor rapid spread are: cut seed, mechanical seed cutters, picker planters, heavy irrigation, poor drainage, washing or treating seed with liquid material not bactericidal as opposed to whole seed, hand cutting, assisted feed planters, lack of irrigation, good drainage and no treatment or treatment with dry materials or liquids containing bactericides. The rate of spread can be very materially reduced by constant use of an effective disinfecting solution on the knife as described by Paschall, Lane and Kreutzer (5, 6) and by Knorr and Vaughn (4).

We now have many observations to indicate that the disease may persist for several years in a seed stock at a level below that of discovery. In New York there was one case where the disease was not detected by inspection till seven years after its introduction. At the time the zero tolerance was adopted it was not thought that this would be possible. It is now evident that the elimination of ring rot from any seed-growing area of considerable size will not be accomplished by official inspection alone. Other measures, including the cooperation of seed growers, will be needed.

CONTAMINATION FROM OUTSIDE SOURCES

In addition to difficulties inherent in inspection which have been discussed, we have to deal with the possibilities of contamination from outside sources. The danger of transmission by the cutting knife has been referred to but we need to point out that this could take place, not only at the time the purchased seed is planted but also in the year previous when planted by the seed grower. The possibility exists that the resulting infected plants would fail to show symptoms during the year of inspection or that the percentage of diseased plants would be too small for detection. Similarly, infection of tubers could take place by transportation in a railroad car or truck which had previously transported diseased stock. This possibility may seem rather remote but when it is considered that many thousands of tubers are subjected to abrasive action against contaminated surfaces in this manner it is obvious that either disinfestation of such surfaces or protection by heavy paper is advisable in the case of seed intended for production of certified seed. Containers used in harvesting as well as those used in marketing can serve as sources of contamination.

RESPONSIBILITY OF PERSONS ENGAGED IN SEED TRADE

There is need for a definition of the responsibilities of seed growers, inspectors, packers, brokers and buyers. In each case the person involved should be expected to exercise due diligence.

For the seed grower (who is also usually the packer) it would mean that he would not knowingly sell seed containing ring rot. A conscientious grower who encounters the disease during roguing or grading would withdraw the potatoes from sale as certified seed. Such action would seem to require that he learn the symptoms on plant and tuber sufficiently well to recognize, at least, the outstanding cases. Doubtful cases should be referred to the inspector or other competent authority.

For the inspector, due diligence would seem to require the making of at least one inspection of the vines during the latter half of the growing

season and of at least one inspection of the harvested tubers. For the field inspection, we may consider 1000 plants as a minimum sample but, in most cases, the practice would be several times this number. In many cases, also, more than one late inspection of vines will be made. Probably the best time for tuber inspection is after the crop is dug but before tubers have been picked up. Since circumstances often make such an inspection impracticable it is then necessary to rely on an inspection of the stock as prepared for shipment. Since obviously diseased tubers will have been removed from those lots, it is necessary that the inspector clip the ends of the tubers examined. In making such inspections examination of the cull pile or observation of the potatoes on the picking table whenever possible would be desirable.

The broker or other middleman is in an unfortunate position since he often does not see the potatoes and must rely on documents provided by the grower and inspector.

PURCHASER ALSO HAS RESPONSIBILITY

The ultimate buyer, who presumably intends to plant the seed, also has a responsibility. Usually he is given an opportunity to make an inspection of the seed, either personally or by an agent. If he does so and ring rot is found (the diagnosis being confirmed by competent impartial authority) he may usually reject the shipment, in which case it will most probably be sold for table stock for the interest of the previous owner. If he is a seed grower it is particularly incumbent on him to make such an inspection and to reject the shipment if ring rot is found. In the case of a table stock grower, however, it is by no means certain that his best interests will be served by rejection of seed containing a small amount of ring rot. He must give consideration to such questions as, how much disease is present, is it likely to cause him a loss, can the seed be replaced with other seed of the same variety likely to be more nearly free from disease and whether, by taking suitable precautions, he can prevent undue loss from planting the seed. It is incumbent on him to answer these questions according to his best judgment. If later events cause him to change his mind he should not expect to evade the responsibility by shifting it to some other person.

For example, take the case of a table-stock grower who has purchased 100 bags of seed. He decides to make no inspection and begins cutting. When 50 bags have been cut he accidentally discovers one tuber showing ring rot symptoms. He now complains to the dealer, who says: "The 50 bags not cut I will take back and sell for table stock, replacing it with other seed. There is no market for the cut potatoes and I will not take them back." The grower, not wishing to throw away the cut seed, plants it. At harvest time he finds that the loss due to ring rot is greater than the cost of the seed. It would not be reasonable for him to expect compensation for this loss from the dealer or other party. The decision to cut, and to plant were his and responsibility for the outcome must be his.

FREEDOM FROM RING ROT NOT GUARANTEED PRECAUTIONS TO TAKE

It should be evident that certification is not and cannot be a guarantee

of freedom from ring rot. The most that can be hoped for is that most lots of certified seed will, in fact, be free and that the percentage in the other lots will be low enough so that serious loss from the disease is unlikely.

ABSOLUTE FREEDOM FROM RING ROT NOT ESSENTIAL FOR TABLE STOCK GROWERS

For the table stock grower, absolute freedom from ring rot is not necessary. The advice given in some bulletins, "Plant only seed known to be free from ring rot" is obviously impossible to follow. Better advice would be: "Plant seed which has been inspected and in which no ring rot has been found." This is essentially certified seed. It is safe to say that thousands of carloads of seed containing small amounts of ring rot are planted every year and, in most cases, those who plant it experience no appreciable loss from this disease and usually do not even know they have had it.

If, in any lot of seed the percentage disease is high, it would be best to discard the seed entirely even if it cannot be replaced. If, however, the percentage of disease is low it may be best to plant the seed. In this case, at least, precautions should be taken against increasing the amount of disease. The chief precaution would be disinfestation of the cutting knife by use of mercuric chloride solution 1:500. If small potatoes are being used, cutting might well be entirely eliminated. If it appears impractical to use a continuously disinfested cutting knife it might be possible to restrict the spread of the disease by disinfestation of the cutting and planting equipment several times a day. For growers of table stock it is doubted whether the disinfestation of containers will be profitable. The danger of contamination from volunteers and cultural operations is also too slight to consider.

EXTRA PRECAUTIONS FOR SEED GROWERS

For seed growers we would strongly recommend that all equipment be disinfested at least once a year, and the most important equipment (seed cutters, planters, and sorters) each time there is a change in the seed source or variety. Danger of contamination from volunteers, cars and trucks and from the rotobearer should be given consideration.

Most certification standards require the use of new bags for certified seed. This is good but is of little value if the cut seed is then put into used bags or contaminated crates. No seed growers should lend or borrow potato equipment, especially planters, unless very positive measures are taken to disinfect it before use with clean seed. There does not appear to be justification for official requirements on these matters because of the wide variation in circumstances and the impossibility of intelligent enforcement. Repeated use of containers without disinfestation should be avoided if possible. Custom washing, treating and grading should never be practiced with seed potatoes, unless suitable precautions are taken.

HOW SEED GROWERS CAN BE SURE OF CLEAN PLANTING STOCK

The question now may be asked: "Since freedom from ring rot cannot be guaranteed by inspection methods, is there no way by which a seed

grower can be sure that he will produce seed free from this disease?" In the absolute sense we probably can give only a negative answer to this question. However, a grower who can produce his own planting stock over a period of several years can engage in a program which should result in almost certain freedom from the disease. Such a program was described in the American Potato Journal in 1944 (3). The program as outlined may need modification to meet individual cases. The essential features of the program are (1) start with a very small quantity of seed, (2) inspect each year at a favorable time and discard the entire stock if ring rot is found and (3) take adequate precautions against outside infection. Ideally the program is started with a single tuber but time will usually be saved by starting with 10 pounds or 100 pounds. The chances of success are reduced as the starting quantity is increased. Several independent selections can be started simultaneously so that, if some have to be discarded, others will still be available for propagation. Each individual selection must be handled in such a way that no contamination will take place from other selections. Failure of the program can result from neglect of any one of the three essential features.

SUMMARY

It is pointed out that it is impossible by inspection methods to guarantee freedom from ring rot. The zero tolerance for certified seed tends to keep the percentage of ring rot low but does not eliminate it. Seed growers should take all precautions possible to keep their fields free from ring rot. Table stock growers should use certified seed or other seed which has been inspected by competent persons and in which no ring rot has been found. If ring rot is found after the seed is purchased, but before planting, the question as to further procedure will hinge on such matters as the purpose of proposed planting, the amount of infection, the possibility of satisfactory replacement if discarded and feasibility of knife disinfestation to restrict the spread of ring rot during planting operations. For seed growers, a program is outlined which should result in ring rot-free seed.

LITERATURE CITED

1. Baribeau, B. 1931. Bacterial wilt of potatoes. Can. Pl. Dis. Surv. Rept. 11: 49.
2. Dykstra, T. P. 1942. Compilation of results in control of potato ring rot in 1941. Amer. Potato Jour. 19: 175-196.
3. Fernow, K. H. 1944. Potato ring rot control for those who think they don't have the disease. Amer. Potato Jour. 21: 14-17.
4. Knorr, Carl and John R. Vaughn. 1948. Potato ring rot control through use of seed dips and the disinfested stationary cutting knife. Mich. Agr. Exp. Sta. Quarterly Bull. 31: 71-82.
5. Paschall, J. L., G. H. Lane and W. A. Kreutzer. 1946. The double-edged stationary potato cutting knife. Colo. Agr. Exp. Sta. Bull. 493.
6. ———. 1946. Comparative effectiveness of certain knife disinfectants and the use of the double-edged knife for the control of ring rot of potatoes. Amer. Potato Jour. 23: 291-299.

NEW TYPE POTATO PLANTER INVENTED¹JOHN S. GARDNER²

This is the story of a potato planter lately invented by Charles F. Schmidt, a long-time potato grower of Jefferson County, Kentucky. It is unique in that it does not employ pickers for "spacing" seed and thus avoids seed damage caused by "picker planters" as follows:

(1) Picker wounds are points for inoculation with the causal organisms (virus) of the "running-out" potato diseases. Therefore, one diseased seed piece contaminates many healthy seed pieces that are stabbed by the picker. This is of primary concern to men engaged in the production of Certified Seed.

(2) Picker wounds are often starting points for rots that sometimes totally destroy seed pieces, or so weaken them that normal sprouting cannot occur. In either case stands are affected and yields reduced.

(3) Sometimes the picker splits the seed piece, neither remnant of which is then capable of producing a profitable hill. Or, as happens frequently, two seed pieces are impaled on the picker and the seed is not only wasted but the yield is also reduced because of the competition between the "doubles".

It is seen, then, that points 2 and 3 are of concern to all potato growers, even those who grow merely tablestock.

DESIGN

This planter consists of a seed hopper, a "spacer" and a chute whereby the seed pieces are delivered into the furrow.

The hopper is of conventional type, differing only in that the seed discharge is fitted with a slide-gate, not only to govern seed flow but to accommodate a wide range of seed piece sizes. Adjustment for rate of seed discharge can be made by raising or lowering the hopper seed discharge spout.

The "spacer", the heart of the machine, consists of a disk on which another disk is superimposed, concentric with it, but of lesser radius, thus leaving a portion of the lower disk exposed. The disk ensemble is given an oscillating motion (2 inches), and the whole is tipped downward for the following reasons:

On the exposed portion of the lower disk the seed falls from the discharge opening of the hopper and the oscillating motion pulls the lowermost from under the pile to start it into a groove edged on its inner side by the upper disk, notched for forward motion. The outer edge is made of raised sections, each capable of motion to hold the seed pieces against the moving notches.

In this manner, the seed pieces aided by gravity are "nudged" down the groove which has at its end a positive-action gate that permits the seed pieces to drop one by one into a chute that delivers them just behind the "opener" and just ahead of the "coverer", as in conventional planters.

Throughout the process, the action is of exceeding gentleness and seed damage is negligible. Then, too, as the spacer is only 2 feet square and 15 inches deep, it may be set as low as wished to obviate any seed damage that might result from a long "fall". Seed damage often occurs in sprouted potatoes.

Practice runs have been made with "wet", freshly cut seed and with suberized seed, as is the custom; and with a mixture of the two. The handling was beautifully precise in each test.

"Exhibition" runs have been made with a mixture of objects, such as various lengths of carrot, 25-watt electric bulbs, the halves of electric plugs and jumbo sweet potatoes. All were handled perfectly except the sweet potatoes which would not pass through the end gate because of their huge size.

It is believed that this development may aid greatly in revolutionizing the present practices in white potato production.

¹Accepted for publication April 17, 1957.

²Extension Horticulturist, Emeritus, Kentucky Agricultural Experiment Station, Lexington, Ky.

BOOK REVIEW

Farm Trouble. By Lauren Soth, Princeton University Press, Princeton New Jersey, 1957. Pp. 221, Price \$3.75.

The writer of this book, a Pulitzer prize winner in journalism, has reduced the highly complicated problems of agriculture to ridiculously simple terms. First he disposes of the political shibboleths about the family farm, rural life, parity, and the middleman. This is followed by consideration of agricultural surpluses, too many farmers, price supports, the ever-normal granary, and making the market work better. The author is much more disturbed by the "neglected one-third" of the farmers whose annual sales total less than \$1,200 a year than he is about those who are primarily responsible for excess production. And he returns to this subject in his final chapter, where he says that there is great need to "increase the mobility of people out of agriculture." In a chapter on "The Soil," the population problem in relation to land resources is presented in the light of Malthusianism, with particular reference to what James F. Bonner, Fairfield Osborn, and William Vogt are saying about people and what John D. Black and Hugh Bennett think should be done about land. The book provides interesting and constructive reading. It has the merit of bringing the problems of agriculture into sharp focus. But the answers to these problems are not at hand.

—FIRMAN BEAR, *Prof. Emeritus, Agricultural Chemistry,*
Rutgers University, New Brunswick, N. J.

CHIP SALES SOAR TO NEW HIGH

Chippers are in the chips all right!

Kim Cranney, president of the National Potato Chip Institute, reported recently that in 1956 the industry grossed 353 million dollars, an increase of more than 14 per cent over the previous year.

Mr. Cranney said that 642 million pounds of chips were produced in the twelve months ending January 1, 1957, bringing the per capita consumption of chips to 3.89 pounds. Ten years ago it stood at 1.8 pounds. He commented:

"It takes a lot of potatoes to process that amount of chips. The industry utilized in 1956 more than 2½ billion pounds — or 22 per cent of the U. S. potato crop. The Institute confidently anticipates that by 1961, the chip industry will be processing 36 per cent of the crop.

"There is evidence everywhere that chips are being considered a staple food item and not merely a snack.

"Acceptance of the concept that no party is a success without a chip dip has not only stimulated chip sales, but has had an enormous influence on the sale of items used in dips."

PROCESSED POTATO PRODUCTS PROVIDE IMPORTANT OUTLET FOR U. S. CROP

Use of processed potato foods in the U.S. is now nine times greater than in 1940 and double that of 1948, even though the amount of fresh potatoes used in households has dropped considerably during the past decade, the U.S. Department of Agriculture reports.

One out of every six pounds of potatoes consumed by the American eating public today is in processed form. The trend continues upward. Technicians of U.S.D.A.'s Agricultural Research Service are playing a major role in developing and improving potato products.

Here's a rundown on some old, new, and yet-to-be marketed processed foods made from potatoes:

Chips, in their common form or in special flavors, are the most familiar of the prepared-food potato products. Several experimental products have been developed using chips or made by methods similar to those of chip making. They include chip bars, crushed chip candy, chiplets, and potato nuts.

Chip bars are prepared by compressing crushed chips into bars occupying only one-twentieth the volume of regular chips. They are on standby status as a high-calorie, high-density military ration. Several different types of *chip candy* containing chip pieces have been made. "*Chiplets*", a fried product, are made from thin, flat, on-half-inch squares of potatoes that are dried and then partially reconstituted in water before frying. "*Nuts*" are prepared by frying one-fourth-inch diced potatoes in deep fat. None of these products is yet produced commercially.

Of the frozen products now on the market, *French fries* are the most important. Also available are puffs, dice, patties, potato soup, and whipped potatoes—all in frozen form.

Puffs are made from mashed potatoes, mixed with wheat flour, eggs, and seasoning, then formed into croquettes and fried in deep fat before freezing. *Diced* potatoes for hash-browning are diced into cubes about 3/8-inch on a side, steam blanched, and then frozen. *Patties* are made from shredded potatoes, blanched and mixed with flour and shortening before freezing. Canned, frozen cream of *potato soup* contains small pieces of potatoes in a flavored cream base. For *whipped potatoes*, the mash is vigorously beaten before freezing.

Dehydrated potatoes in several forms are on the market or in the testing stage. These include dice, granules, flakes, and shreds.

Most of the dehydrated potatoes being produced are in the form of the *dice*, with their biggest use in canned stews and hashes. New and improved methods of producing *granules* have been developed, and production has increased continuously since their commercial introduction in 1947. *Potato flakes* are made from mashed potatoes, dried in sheet form, then broken into flakes before packaging. Riced potatoes are dried in small hollow cylindrical pieces to make *potato shreds* that can be reconstituted to mashed potatoes. With the exception of potato flakes, all these dehydrated products are on the market. In a recent market test, experimental potato flakes sold well, indicating homemakers like them.

A new use for *potato starch*—one of the older potato products—is in “instant” puddings. Another important processed product is *canned potatoes*, put in brine packs and in hashes, stews, and salads. *Potato flour*, on the market since shortly after World War I, is used principally in potato bread, doughnuts, and specialty items.

Pre-peeled potatoes are now moving into retail trade, although most of them are distributed only through wholesale channels.

**Increased Stands, Bigger Yields, More
Profits when Potato Seed Pieces Are
Treated with**



**ORTHOCIDE
75 Seed Protectant**

ORTHOCIDE not only protects potato seed pieces from seed rot and damp-off at planting, but this treatment continues its protective work *after* planting. Result—*much greater production*—growers report from 17% to 100% increase in stands! Also potato seed pieces dipped in an ORTHOCIDE 75 Seed Protectant dilution can be held several days without deterioration—thus enabling growers to cut pieces in advance of planting, without costly, time-consuming interruptions to cut more pieces.

CALIFORNIA SPRAY-CHEMICAL CORP.

Richmond, Calif.

Offices Throughout U. S. A.

TM'S ORTHO. ORTHOCIDE REG. U.S. PAT. OFF.

ORTHO





"DITHANE gives us everything we expect from a potato fungicide. It keeps blight out of our fields, it is mild on foliage, it gives us better yields on potatoes that come out of storage in good shape."

"DITHANE gives us everything we expect from a potato fungicide."

W. J. DICKSON, Dickson Bros., Gilby, North Dakota

The top growers in this potato business know all the tricks—such as using DITHANE fungicide for blight control. And to get best results, they always spray DITHANE early and keep on spraying it right through the season.

That's why these leaders consistently get higher yields and more No. 1's per acre. By sticking with DITHANE, they also get potatoes that can't be beat for dry matter content, cooking or chipping qualities and storage properties.

The difference in DITHANE is that it gives maximum protection against blight without harming blossoms or vines (when used as recommended). It enables the vines to remain green and vigorous longer . . . to give you tubers at their best.

See your dealer now for DITHANE D-14 (nabam) or dusts based on DITHANE Z-78 (zinab).

DITHANE is a trade-mark,
Reg. U.S. Pat. Off. and
in principal foreign countries.



Chemicals for Agriculture

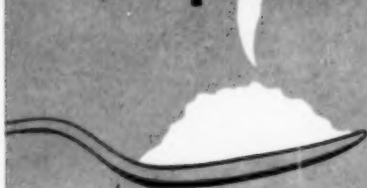
**ROHM & HAAS
COMPANY**

WASHINGTON SQUARE, PHILADELPHIA 5, PA.

Representatives in principal foreign countries

University Microfilms
313 North 1st St
Ann Arbor Michigan

the proof is in the eating



The Housewife may not realize it but that "better tasting" potato is one that was sprayed with TRIANGLE

BRAND COPPER SULPHATE. Spraying with Triangle Brand Copper Sulphate in Bordeaux Mixture to control blight is a safe and economical way to insure a good crop. It gives a better yield of No. 1's, with better storage expectancy, and helps the potato retain its NATURAL FLAVOR. This means increased consumer acceptance and greater profit to the grower. Despite the claims made for organic fungicides, experienced and successful growers still prefer time-tested COPPER SULPHATE for the control of early and late blight. Try it on your crop and see the difference.

CONTROL POND SCUM AND ALGAE in farm waters with TRIANGLE BRAND COPPER SULPHATE.

FENCE POST treatment with TRIANGLE BRAND COPPER SULPHATE prevents decay and termite damage.



Send today for information on these important uses of copper sulphate.

PHELPS DODGE REFINING CORPORATION

300 Park Ave., New York 22, N. Y. • 5310 W. 66th St., Chicago 38, Ill.